CSA 2201
Formal Languages and Compilers

Assignment 1

This assignment is worth 15% of the final mark of the Formal Languages and Automata course. The documentation explaining your results are to be handed to the departmental secretary by Monday 3rd November 2008. Assignments handed in late will be marked down by 3 marks (out of 15) per day. No assignments will be accepted after Friday 7th November 2008.

The Department of Computer Science and AI takes a very serious view on plagiarism. Refer to the departmental website on plagiarism for more details:

http://www.cs.um.edu.mt/resources/plagiarism/

You are to solve all of the following problems.

Question 1 carries 5 marks. Question 2 carries 10 marks.

1. Give a Phrase Structured Grammar accepting each of the following languages:

(a) \( L_1 = \{a\}^* \)
(b) \( L_2 = \{a^n \mid n \geq 0\} \)
(c) \( L_3 = \{a^n \mid n \geq 1\} \)
(d) \( L_4 = L_1 \setminus \{\epsilon\} \)
(e) \( L_5 = L_1 \cup \{b^n \mid n \geq 1\} \)

2. Consider the following two grammars:

\[
G_1 = \begin{cases}
\Sigma = \{a,b\} \\
N = \{A,B\} \\
S = A \\
P = \begin{cases} 
A \to aB, \\
B \to bB, \\
B \to a 
\end{cases}
\end{cases} \\
G_2 = \begin{cases}
\Sigma = \{a,b\} \\
N = \{A,B,C\} \\
S = A \\
P = \begin{cases} 
A \to aB, \\
B \to bB, \\
B \to bC, \\
C \to a 
\end{cases}
\end{cases}
\]

(a) Prove that \( L(G_1) \neq \{ab^na \mid n \geq 1\} \).
(b) Prove that \( S(G_2) \subseteq \{A, ab^mB, ab^nC, ab^nA \mid m \geq 0, n \geq 1\} \).
(c) Prove that \( \{ab^mB \mid m \geq 0\} \subseteq S(G_2) \).
(d) Using (b) and (c) above, prove that \( L(G_2) = \{ab^n a \mid n \geq 1\} \).